

## PATENT COOPERATION TREATY


## PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT  
(PCT Article 36 and Rule 70)

REC'D 13 MAY 2005

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Applicant's or agent's file reference 024157.WO	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/NL 03/00941	International filing date (day/month/year) 24.12.2003	Priority date (day/month/year) 24.01.2003
International Patent Classification (IPC) or both national classification and IPC H01L31/05		
Applicant STICHTING ENERGIEONDERZOEK CENTRUM NEDERLAND et al		
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 5 sheets.</p>		
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>		
Date of submission of the demand  07.06.2004	Date of completion of this report  11.05.2005	
Name and mailing address of the international preliminary examining authority:   European Patent Office - Gitschiner Str. 103 D-10958 Berlin Tel. +49 30 25901 - 0 Fax: +49 30 25901 - 840	Authorized Officer  Visentin, A  Telephone No. +49 30 25901-762	



**INTERNATIONAL PRELIMINARY  
EXAMINATION REPORT**

International application No. PCT/NL 03/00941

**I. Basis of the report**

1. With regard to the elements of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

**Description, Pages**

3-6 as published  
1, 2, 2A received on 04.04.2005 with letter of 01.04.2005

**Claims, Numbers**

1-10 received on 04.04.2005 with letter of 01.04.2005

**Drawings, Sheets**

1/2-2/2 as published

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).  
☐ the language of publication of the international application (under Rule 48.3(b)).  
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.  
☐ filed together with the international application in computer readable form.  
☐ furnished subsequently to this Authority in written form.  
☐ furnished subsequently to this Authority in computer readable form.  
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.  
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:  
☐ the claims, Nos.:  
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

**V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Yes: Claims	1-10
	No: Claims	
Inventive step (IS)	Yes: Claims	1-10
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-10
	No: Claims	

2. Citations and explanations

**see separate sheet**

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**Re Item V**

**Reasoned statement with regard to novelty, inventive step or industrial applicability;  
citations and explanations supporting such statement**

1.) In this report reference is made to the following document:

D1: US-A-5009243

2.) The subject-matter of claim 1 of the present application meets the requirements of Art. 33(2)(3) PCT, because it is considered as new and inventive with respect to the cited state of the art.

The document D1 is regarded as being the closest prior art to the subject-matter of claim 1 and shows:

a coupling device for electrical coupling of a first photovoltaic cell to a second cell, which comprises at least one magnetic pressing element for positioning electrical contact means on and in electrical contact with a part of respectively the first and the second cell (see D1, column 5, line 19-column 6, line 30; figures 1-4).

The subject-matter of claim 1 differs from this known device in that the contact means comprise an electrically conductive layer on co-acting edge zones of the first and the second solar cell for bringing these cells into electrical contact in overlapping state of these edge zones.

The problem to be solved by the present invention may be regarded as to facilitate the series connection between two solar cells contacted by overlapping the edge zones of the two cells, so that a tab contact is not necessary.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) for the following reasons:

no one of the documents cited in the International Search Report proposes or suggests such type of edge contacts between solar cells. Moreover this technical features cannot be judged as obvious for the skilled man.

Consequently the subject-matter of claim 1 of the present application is considered new and inventive.

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3.) Claims 2-10 are dependent on claim 1 and as such also meet the requirements of the PCT with respect to novelty and inventive step (Art. 33(2)(3) PCT).

4.) All claims 1-10 meet the requirements of industrial applicability of Art. 33(4) PCT.

5.) The subject-matter of claim 1 is not clear in the sense of Art. 6 PCT.

Indeed considering in claim 1 the case of only one magnetic pressing element used for positioning electrical contact means on the first and the second cell being in electrical contact on co-acting edge zones, it is not clear to the skilled man how such a contact could be established. Apparently, to keep two solar cells in electrical contact at their edge zones by one magnetic pressing element, a magnetic layer or a magnetic substrate in at least one solar cell should be used, so that the pressing force of the magnet could be activated. Otherwise no pressing force on the solar cells, derived by the magnetic element, can be active.

Consequently it is considered that the subject-matter of claim 1 lacks essential features (Art. 6 PCT).

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## COUPLING DEVICE FOR THIN-FILM PHOTOVOLTAIC CELLS

The invention relates to a coupling device for electrical coupling of a first thin-film photovoltaic cell to a second thin-film photovoltaic cell, which coupling device comprises at least one magnetic pressing  
5 element for positioning electrical contact means on, and in electrical contact with, at least a part of respectively the first and second cell.

A thin-film photovoltaic cell usually consists of a carrier foil, on one side of which is deposited a  
10 photoactive layer which is provided with conductors for transporting in a first direction charge carriers generated under incident light. The carrier foil is provided on its other side with an electrically  
conductive layer, or consists wholly of a conductive  
15 material, for the purpose of transporting charge carriers in a second direction opposed to the first direction.

The photoactive layer comprises for instance copper indium selenide ( $\text{CuInSe}_2$ , usually referred to as CIS), on  
20 which a pattern of aluminium (Al) conductors is arranged, which layer is deposited on a metal carrier foil, for instance of Titanium (Ti), wherein an intermediate layer of sodium fluoride (NaF) is preferably applied in order to enhance the adhesion of  
25 the CIS.

In another thin-film photovoltaic cell the photoactive layer comprises for instance amorphous silicon (Si) deposited on a metallized plastic carrier foil, for instance a foil of polyethylene (PET) which is  
30 provided on its underside with a conductive coating layer.

It is a problem of the known thin-film photovoltaic cells that they are mechanically vulnerable and, as a result thereof, are difficult to connect electrically in

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series. An electrical series connection is for instance realized using an aluminium strip between the aluminium conductors of a first cell and the titanium carrier foil of a second cell, this strip being fixed by ultrasonic  
5 welding. Because the adhesion between the photoactive layer and the carrier layer is impaired at some positions during welding, the welding often results in damage to the photovoltaic cells.

From US-A-5009242 is known a solar harness  
10 apparatus which includes a plurality of solar cells with each having an active surface, that is a surface that absorbs photons to generate electrical power, and these are arranged in substantially parallel fashion with the active surfaces all facing the same direction and with  
15 the solar cells being stacked in line behind one another. This solar harness includes a plurality of magnets with at least one magnet being located between each adjacent solar cell in the plurality of solar cells so as to hold the cells in the stacked arrangement  
20 without any further support and so as to create solderless contacts therewith.

US-A-5009242 does not disclose a coupling device for electrical coupling of non-stacked or thin-film photovoltaic cells, it neither discloses a coupling  
25 device wherein electrical coupling is effected by the direct mechanical contact between a first and second cell, without use having to be made of a strip-like or other conductor between the first and second cell.

It is an object of the invention to provide a  
30 coupling device for electrical coupling of thin-film photovoltaic cells which does not result in damage to these cells.

It is a further object to provide such a coupling device, using which thin-film photovoltaic cells can be  
35 coupled in efficient, rapid and reliable manner.

~~2~~ 2 A

These objects are achieved with a coupling device of the type stated in the preamble, in which according to the invention the contact means are provided by an electrically conductive layer on respective co-acting  
5 edge zones of the first and the second cell for bringing about, in overlapping state of these edge zones, an electrical connection between the first and the second cell. The electrical coupling is herein effected by the direct mechanical contact between the first and second  
10 cell, without use having to be made of a strip-like conductor between the first and second cell.

In a practical advantageous embodiment, a coupling device according to the invention comprises two co-acting permanent magnetic pressing elements for  
15 receiving therebetween in mutual electrical contact at least a part of the first and second cell. Two cells



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## CLAIMS

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1. Coupling device for electrical coupling of a first thin-film photovoltaic cell (1) to a second thin-film photovoltaic cell (2, 3), which coupling device comprises at least one magnetic pressing element (7) for positioning electrical contact means on, and in electrical contact with, at least a part of respectively the first (1) and second cell (2, 3), characterized in that the contact means comprise an electrically conductive layer (6) on respective co-acting edge zones of the first (1) and the second cell (2, 3) for bringing the first (1) and the second cell (2, 3) into electrical contact in overlapping state of these edge zones.

2. Coupling device as claimed in claim 1, characterized in that it comprises two co-acting permanent magnetic pressing elements (7) for receiving therebetween in mutual electrical contact at least a part of the first (1) and second cell (2, 3).

3. Coupling device as claimed in claim 2, characterized in that the magnetic pressing elements comprise a layer of a permanent magnetic material on the respective co-acting edge zones of the first cell and the second cell.

4. Coupling device as claimed in claim 1, characterized in that the at least one magnetic pressing element comprises a layer of a permanent magnetic material on the first edge zone of the first cell, and the second cell is provided with a layer of a ferromagnetic material on the second edge zone.

5. Coupling device as claimed in claim 4, characterized in that the second edge zone of the second cell is the edge zone of a carrier foil containing a ferromagnetic material.

6. Coupling device as claimed in any of the claims 3-5, characterized in that the respective electrically

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conducting layers (6) are provided on the respective layers of the permanent magnetic and the ferromagnetic material.

7. Coupling device as claimed in any of the claims 5 4-6, characterized in that the ferromagnetic material is selected from the group of materials comprising iron (Fe), cobalt (Co) and nickel (Ni).

8. Coupling device as claimed in any of the claims 3-7, characterized in that the electrically conducting 10 layer contains gold (Au).

9. Coupling device as claimed in any of the claims 1-8, characterized in that it is provided with locking means (8) for locking two cells (1, 2, 3) coupled to the coupling device against displacement in the direction of 15 the plane of these cells.

10. Coupling device as claimed in claim 9, characterized in that the locking means comprise a locking pin (8) of an insulating material extending through co-acting openings formed in the at least one 20 pressing element (7) and the first (1) and second cell (2, 3).